THE SIXTH GRADE

The central topic of study in this grade is transportation. Both land and water travel are studied and as much of the historic background as is necessary for the understanding of present-day conditions is taken up. It is hoped that the outcome of this study will be a knowledge of the development of methods of transportation from the crude log boat and the dog-sledge to the modern steamer and locomotive, with some idea of the changing social and economic conditions which accompanied the opening up of roadways and the change in methods of travel.

Many of the problems related to the central topic are worked out in detail in the science and the manual-training departments. For example, the evolution of the means of propulsion of watercraft from hand-power to steam, gas, and electric power is studied, and models of the various types of boats of different historic periods are made in the woodshop. The effects of heat on liquids, the conversion of water into steam, and the use of steam, as motive power are topics worked out in the science classes where use is made of the laboratory and its equipment. A survey of the early methods of trail and road-making introduces the bridge and its influences, a topic which is studied in detail in the shop. Here the primitive bridge, its modifications after the wheel came into general use, the development of the modern structure and the modifications it has undergone in adaptation to special needs are studied, and models are made of representative types.

Whenever the grade discussions bring up topics which can best be handled in the laboratory or which require special treatment, they are worked out under the guidance of the science teacher. Since the interest of the pupils always determines the choice of topics, no two groups of sixth-grade children have had identical experiences in general science; the following topics, however, will give an idea of the field that is covered through a study of transportation and will show how the parallel science course clarifies and intensifies the central topic.

I. A survey of early water transportation. Exhibits of primitive boats in the Field Museum are studied, and models made of special types. Buoyancy, and weights of various liquids are the related science topics.

II. Beginnings of ocean travel. Science topics; the mariner's compass, magnetism, the North Star as an aid to navigators.

III. The class becomes familiar with the leading steamship companies by a study of newspaper advertisements and of the bulletins furnished by the various companies whose offices the children visit.

IV. The foreign destinations and routes of travel are studied, and the influence of ice upon the location of these routes is noted. The problems arising from this study which required fuller treatment than could be given by the grade teacher were: Why can icebergs live so long? Why does the larger part of the berg float below the water? Where do ships encounter the greatest danger from bergs? Why are the North Pacific routes not hindered by icebergs? Why are icebergs often hidden by fogs? How are sailors warned of the nearness of ice-fields? Science topics: Evaporation and condensation, the effects of heat and cold upon metals, the principle of the marine thermometer.

V. The structure and size of modern vessels. The science topics studied are steam, its uses, the turbine, and reciprocating-engine.

VI. The big ship-building centers and the reasons for their locations. The related science work is a study of coal, limestone, iron, steel, and oil.

VII. The readjustment in world commerce as wooden boats were displaced by steel vessels.

VIII. The invention of the screw-propeller and its influence on ship-building and commerce. Science topics: Principle of the propeller as applied to boats, aeroplanes, etc.

It is not the plan of the science department to adhere strictly to the curriculum, as outlined in this report. Whenever the children have made experiments outside of school or have discovered facts which interest them, they are encouraged to make a presentation of their experiments or set forth their ideas to the class. During the year several of the children became so interested in this sort of investigation that they fitted up simple laboratories at home.

In order that the science experience may make a lasting impression, wide use is made of models. Such models the children make out of clay, wood, meccano, or other materials. During the school year, each child has an opportunity to make several of these models, which are used in class demonstration and in morning exercises.

In the hope of arousing in each pupil a feeling of responsibility for contributing to the body of science knowledge acquired by the grade, a definite amount of time per week is given to silent reading on topics under discussion. Each child is provided with a printed list of references, from which he may make his own selection. The titles of these articles were reworded by the teacher to make them somewhat suggestive of material to be found in the article. The books and magazines so used are kept on the reference shelf in the grade room, and may be taken out for home use. Each pupil keeps a record of the reading done, and makes a brief criticism on the helpfulness of the article or on his readiness to recommend it to others.

Many children have shown a tendency to read articles directly connected with class discussion, while others have preferred reading at length on some topic of particular interest to the individual. For example, one pupil has read all of the articles on magnets and performed for the class some suggested experiments, while another is reading all the library has to offer on the subject of flying machines and airships. A page from the reference list, with the children's comments, is appended.

REFERENCES FOR SILENT READING

Boys' and Girls' Book Shelf

1. Icebergs, Vol. 15, p. 189. *I found it very interesting.—Louise.*
2. Why an Iceberg Floats, Vol. 16, p. 413. *I liked both articles about icebergs.—Louise.*
3. Magnetism, Vol. 12, p. 413. *I read all of the articles about magnets. They are very good.—Jean.*
4. Magnets, Vol. 12, p. 411.
5. Artificial Magnets, Vol. 8, p. 408.
6. Electro-magnets, Vol. 12, p. 329. *I think everybody should read it.—Marie.*
7. Electro Magnetism, Vol. 8, p. 411.
8. Why an Iron Ship Floats, Vol. 10, p. 410. *Short, but explained clearly.—Beatrice.*
9. Building a Great Ship, Vol. 15, p. 1.
10. On the Bridge of a Great Ship, Vol. 14, p. 401. *I liked it. I studied it for my morning exercise.—Jean G.*
11. Why the Sea Is Salt, Vol. 16, p. 411.
12. Why the Sea Never Freezes, Vol. 16, p. 41.
13. Why Its Waters Do Not Sink, Vol. 10, p. 215.
14. Size of the Ocean, Vol. 6, p. 404.
15. Why Iron Turns Red, Vol. 10, p. 413.
16. Effect of Rust on Iron, Vol. 10, p. 289. (*Each member of the class read the references about iron before visiting the steel mills.*)
17. Why Iron Can Be Bent, Vol. 5, p. 168.
18. Why Iron Feels Colder than Wood, Vol. 5, p. 168.

19. Submarines, Vol. 15, p. 38. *I read the whole series on submarines.—James.*
20. A Submarine on an Ocean Floor, Vol. 15, p. 47.
21. Flying Machines and Airships, Vol. 15, pp. 139, 153. *I read all about aeroplanes.—John.*
22. Airships and Balloons, Vol. 6, p. 228.
23. How a Balloon Is Sent Up, Vol. 5, p. 144. *The articles were good, but rather simple if you understand aeroplanes.*
24. Flight of a Balloon, Vol. 6, p. 415.
25. Pets on Shipboard, Vol. 2, p. 374. *It is worth while reading.—Laura.*
26. Warships, Ancient and Modern, Vol. 8, p. 335. *Interesting and exciting.—Jessie.*
27. Dogs on the Battle Field, Vol. 14, p. 303. *A very good article.—Murray.*
28. Nature Giants That Man Has Conquered, Vol. 15, p. 7. *I recommend it to others.—Ward.*
29. Queer Things About Explosives, Vol. 16, p. 336. *Easy to read and interesting.—Laura.*
30. Boy Who Rode on the First Train, Vol. 18, *I liked it.—Thompson.*
31. Triumphs of Science, pp. 147, 84, 69, 57. *I read all about submarines. —John.*
32. Popular Mechanics. *The article about provision motors is very good. I liked it best.—Bernal.*

The principal topics, with some of the detailed experiments carried on in the laboratory as part of the sixth-grade work, follow. It is not to be understood that these are the only experiments given, but that they are fairly representative of the work.

I. *Primitive Boats*—The first problems which arise are: Why do ships and other bodies float? Why does a steel ship float while iron sinks? How are skin boats and floaters made? To answer these questions, buoyancy is studied and the weight of various liquids compared. (See under V. *The Study of the Steamboat.*)

A further problem is: How do fishermen at sea obtain a supply of fresh water?

Experiment.—Freeze both salt and fresh water; taste both liquids and ice from each. Note results and answer questions. (It must be remembered that the flow ice may have been glacial ice.)

Another problem is: Since ice comes from water, why does it float rather than sink?

Experiment.—Freeze water in a test-tube, a sealed Mason jar, or a closed can. Note results and formulate a rule about the behavior of water when it changes to ice.*

*Certain of these experiments may be left for a time later in the year, when the temperature is right.

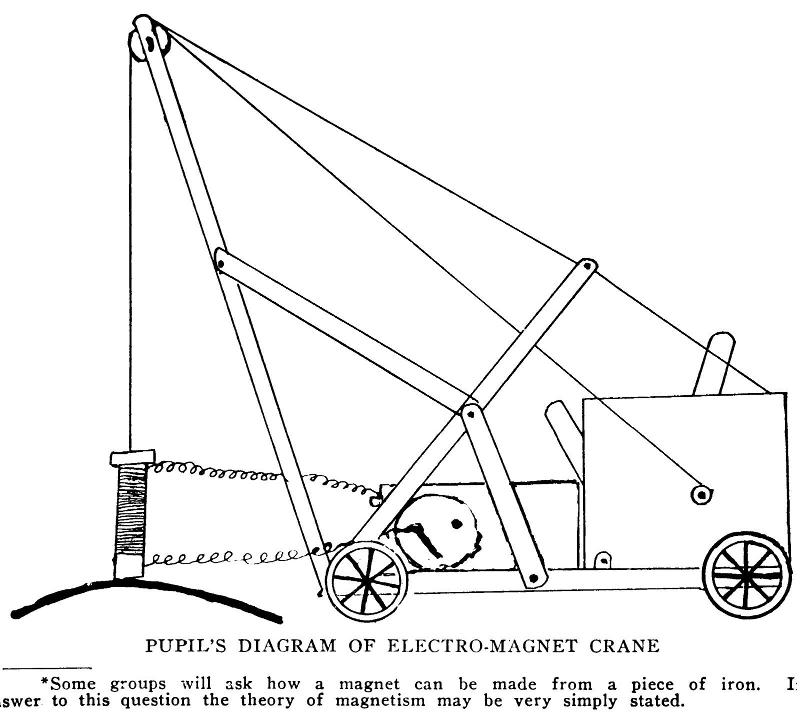
II. *Beginnings of Ocean Travel.*—The questions which present themselves are: How did early navigators know their directions at night or when they were out of sight of land? How did the invention of the mariner's compass solve this problem? How is the mariner's compass made and used?

Experiment.—Let each child take a common sewing-needle and float it on a cork in a vessel of water. What direction does the needle take? Rub the needle on a magnet to magnetize it, and again float the needle. Compare this result with the first, and also with the compass. Suspend a bar-magnet in the room by means of a thread and wire stirrup and again compare with compass. Do other substances besides iron and steel become magnetized?*

Experiment.—By means of a magnet with marked ends, identify the ends of a floating magnetized needle. Also identify ends of the compass-needle in the same way.

Experiment.—The electro-magnet. Place a compass in a coil of wire and pass an electric current through the coil. Let the children see that an iron magnet is not necessary to set up a magnetic disturbance. Discuss the uses of electro-magnets.

As an outcome of the study of the electro-magnet, one of the



PUPIL'S DIAGRAM OF ELECTRO-MAGNET CRANE

*Some groups will ask how a magnet can be made from a piece of iron. In answer to this question the theory of magnetism may be very simply stated.

boys devised an electro-magnet crane and another planned an electric reciprocating engine.*

AN ELECTRO-MAGNET CRANE

The electro-magnet crane is a new invention for lifting steel and iron without fastening. The principle on which this works is an electric current circling in an insulated wire, which is wrapped around a piece of soft iron. Some men think a piece of iron or steel is made of little particles, which have two poles, a north and a south pole. These little particles cannot be seen even under a very powerful microscope. These poles, before the circling of electricity, are all facing in different directions, but while the electricity passes around it, the north poles all face in one direction and create a power to draw steel or iron. The reason steel is not used for an electro-magnet is because once steel becomes magnetized it stays magnetized for a long time, but iron loses all magnetism as soon as the current is broken.

February 25, 1918. John.

III. *Steamship Lines.*—This topic has no related laboratory work.

IV. *Influence of Ice on Steamship Routes.*—Why do fogs occur about icebergs? In order to solve this problem, it is necessary for the children to know something about evaporation and condensation. Afterwards, application of these topics is made to the distribution of rainfall over the earth.

Experiments.—Heat equal amounts of water in an open dish and in a test-tube. Which requires the longer time for evaporation? Hold a cold plate over vapor coming from heated water. Let water vapor from a warm teakettle enter an ice-cold Mason jar. Distill some water. Observe all the changes in these processes.

A discussion following these experiments enables the children to explain why mist and fogs occur about icebergs.

Why does it rain much on the windward side of high mountain ranges and but little on the leeward side? Why do we have snow-capped mountains in desert regions? A relief-map of the world is put before the class. The direction of the prevailing winds is given and the pupils are asked to predict as best they can the relative rainfall of various parts of the earth. Their predictions are checked by reference to a rainfall map in Longman's Atlas.

It is logical to follow the discussion on evaporation and condensation with a brief study of the effects of heat upon gases and solids.

Experiments.—Fit a flask with a rubber stopper and a U-tube containing mercury or water. Heat the flask and note expansion of air.

*Most of the children have erector outfits and are inclined to use them as a means of demonstration.

Fit a flask with rubber cork and upright glass tube. Fill with colored water. Heat flask and note rise of water in the tube.

Arrange a copper rod in a circuit with an electric bell so that the bell rings upon the contact of the copper rod as it lengthens when heated.

The children may be asked to devise thermometers and fire-alarms in which the principle of expansion of solids when heated is involved. They can construct such thermometers or alarms and use them in a class demonstration or in a morning exercise. During the year 1917-18, the children planned a number of marine thermometers and presented the morning exercise which follows:

MORNING EXERCISE—ICEBERGS

Friday, November 23, 1917

Thompson. One of the most northerly Atlantic steamship routes is that of the Allen Line, which runs from Montreal and Quebec *(pointing to the map)* up through the mouth of the St. Lawrence, past the northern coast of Newfoundland, and across the Atlantic to the British Isles. It is from twenty to one hundred miles shorter than any other route, and saves about a day in time. This route cannot be used except in the winter months on account of the icebergs. In the winter, all this region *(pointing to the map)* is a mass of ice, but in summer the lower part melts away, which frees the upper part, thus giving it a chance to break up and come down. These floating masses are called icebergs. Since the *Titanic* disaster, a great many investigations have been made about icebergs and their movements. This morning, we will tell you about the results of some of these investigations.

Beatrice. When the sailors see great masses of floating ice, they are able to recognize two kinds of icebergs. One is very level, just like the top of a table; the other sharp and irregular, extending out of the water like a spire. The first is formed on the water and the other on the land. When ice is frozen on a level surface, it is always level, though it may be many feet deep. So the level ice is that which is frozen on the surface of the northern seas and floats off in large fields when the warmer weather causes it to break up. The land ice differs from that formed on the water, because it is frozen on an irregular surface. So instead of being level, it is rough and uneven. As land ice is formed under great pressure, it is also harder and bluer in color than water-ice.

William. Greenland is the largest body of land north of the arctic circle. On Greenland there are perpetual snows. It will snow and then thaw, and these thaws are sometimes followed by sudden freezing, which converts the snow into ice. This is repeated until there is an ice-sheet over the country many feet in depth. This is sometimes called the continental ice-sheet. This ice-sheet starts to move towards the coast. What causes this movement no one knows, but there are several theories. One is, that when ice is frozen under great pressure, it will flow like thick tar. Another theory is that in winter the ice contracts and in summer it expands and these changes cause a slow forward movement. Ice, in the interior of the country, moves about seven inches a day, while near the shore it moves much more rapidly,—about thirty or forty feet a day. The rate of movement depends upon the steepness of the slope and upon the temperature. During Greenland's short summer of two or three months several thousand icebergs are discharged into the sea.

Lambert. When the moving mass of ice has crept to the sea, the formation of the coast determines the way in which it will break off to become an iceberg. If the coast is high, and steep, like this *(sketching on the blackboard)*, the ice-sheet moves forward, pushing the end beyond the cliff until it becomes so heavy that a great mass breaks off and falls into tne water below. If the coast has a long, gentle slope, like this *(sketching)*, the moving glacier follows the slope and may go some distance under the surface of the sea. As ice is lighter than water, the water always tries to buoy it up and at last a berg breaks off, rises, and floats away.

Since ice is not very much lighter than water, a large part of the berg floats beneath the surface. In this vessel of colored water I have placed a piece of ice and a piece of cork. The piece of cork is very light, so that only a small part of it is beneath the surface. The ice is almost as heavy as water, so that only a very small part of it is above the surface, about seven-eighths of it being under water.

Katherine. After the iceberg has broken from the glacier, it stays around the coast for a long time. There are two forces which finally cause it to go out to sea—the wind and the current. When the iceberg extends several hundred feet above the water the extended part acts just like a sail. The wind catches it and blows the berg down to the sea. The current, which helps in this work is the Labrador current, in Davis Strait. The icebergs are caught in this current and carried down into the paths of commerce. While confined between the shores of Greenland and Canada, this current flows very steadily and swiftly, but when it gets to the ocean, it spreads out like a fan, part of it following the coast of Labrador and the other part moving outward toward the east. Thus this current carries some icebergs to Labrador and down our Atlantic coast to the Gulf of St. Lawrence, while others are carried out into the ocean.

James. Just off the southeast coast of Newfoundland, in the vicinity where the *Titanic* disaster occurred, many icebergs are often held together in a kind of jam. This is due to the action of the current. The Labrador current brings the bergs down along our eastern coast, and when it spreads out some of them are carried out to sea. The Gulf Stream comes up from the south, and in this part of the ocean *(pointing to map)* the two currents meet. Where the two currents push together with the same amount of force, the icebergs are held in a jam, which sailors fear very much.

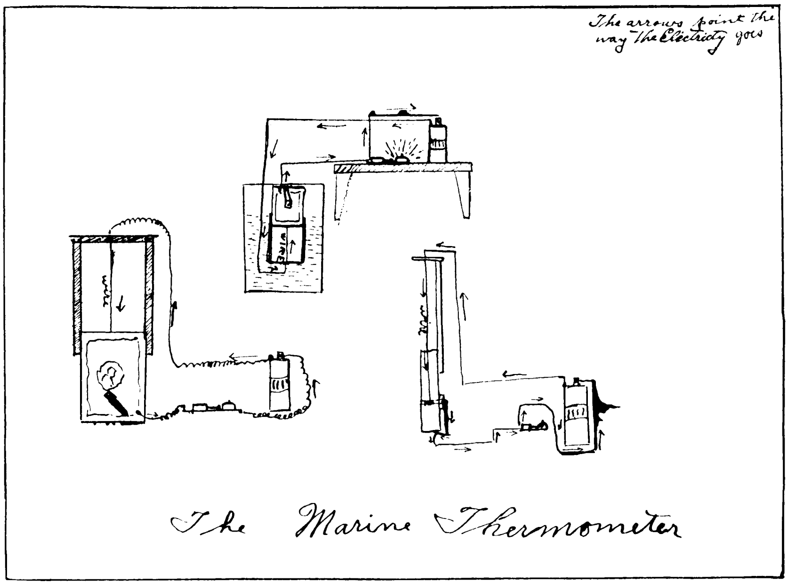
Philip. After an iceberg gets into the Atlantic, it lives for a considerable time. It may live many months, and some bergs have been known to exist for two or three years. There are several reasons for this. One is its enormous size, and another is that on account of the hardness of glacier ice, from which the berg was formed, it will not melt readily. The third reason is that icebergs do not often travel singly, but in fleets. At certain seasons thy break off and many come down into the ocean at the same time. The most advanced bergs cool both the water and the atmosphere around them, so that the sun cannot easily affect them. Another protection to the berg is the fog which forms around it, and keeps off the rays of the sun. Later, Robert will perform an experiment showing how this fog is formed.

Ward. If an iceberg were not carried south by the wind and current, it would live a greater length of time than it usually does. The temperature of the air and water around Greenland is very cold, and therefore the iceberg would have a chance to exist for a long time. But as the iceberg is carried south, it soon comes to a warmer climate. The air about the berg is then warmer than the water in which it floats. But when it reaches the Gulf Stream, the water is warmer than the air around the iceberg and therefore the under part melts much faster than the part that extends above the surface of the water. This thawing of the under part in time causes the iceberg to become top-heavy. Then it will turn over. Sometimes an iceberg turns completely over several times during the process of thawing. Icebergs have been known to be so tall that when they turned over, they struck the ocean floor and were held there for quite a while. This occurs in the shallower water near the coast.

Robert. Icebergs are a great menace to sailors, who are continually on the watch for them. There are many ways in which sailors can detect the presence of bergs. I am going to tell you some of them. One is that on a clear sunny day sailors sometimes see a curious bright flickering light on the horizon. They know this is caused by the ice, although they may not see the iceberg. It is caused by the reflection from the iceberg. Another indication of the nearness of icebergs is the presence of a bank of mist. This mist is formed from the warm moist air above the Gulf Stream coming into contact with the iceberg, which condenses it into mist. I am going to show you by an experiment how this can happen. The air above this jar is warm and moist, like the air above the Gulf Stream. This Mason jar is cold, like the icebergs *(he empties ice from a Mason jar and holds the cold jar over the one filled with hot water)*. The vapor on the inside of this jar is formed like the fog that is around the iceberg.

Mr. M. (holding the jar up so that the audience may see). There is a considerable amount of vapor, in this jar.

Oehm. Another way to detect icebergs is by the use of a marine thermometer. This thermometer works on the principle that copper wire contracts when cooled. The wires are arranged like this *(makes a drawing on board)*. When these two wires contract, they pull a lever, which is connected with a circuit. This rings a bell up on the ship's deck or shows a red light on the navigation-bridge. I have a little device here that works on the same principle as the marine thermometer. I have a copper wire running from this part *(holding up device constructed from a cigar-box, with copper plates and wires)* up through a spindle, and it is wound around the spindle, so that if the wire contracts, it will touch here and will turn the stem and will touch this and cause the bell to ring. I am going to place this in very cold water. *(He does so, and the bell rings.)* That



is the way it rings when the wire contracts. Sailors have found this a very dependable means of knowing when they are approaching floating ice.

Margaret. We made this to represent a marine thermometer, like that used on ships. This is made on the same principle as the one Oehm described. When a solid is heated, it expands, and when cooled, it contracts. So, when this copper wire is put into ice-water, the wire contracts, pulls this lever, and that pulls the wire and a bell rings (*this device was much larger, constructed from a wooden box).* This copper wire is drawn from this spindle to this other spindle. Then there is another copper wire from this spindle, and it connects with a battery. Then there is another copper wire from the first spindle to an indicator. There is another wire on the back that extends to the battery. When this copper wire contracts, it pulls the indicator, which touches this wire and makes the connection, thus ringing the bell.

Dorothy. Sailors on the Atlantic ocean fear icebergs, but those on the Pacific ocean do not. The reason for this is that there are few bergs in the Pacific ocean, because there is no great land mass extending far north where the icebergs can form. There are some glaciers formed in Alaska, but when these reach the coast and break off, forming icebergs, they stay near the shores until they melt away. There are icebergs in the Arctic ocean, but they do not come down into the paths of commerce, because the only way they can get into the Pacific ocean is through Bering Strait, and as that strait is very shallow and very narrow, bergs do not pass through it. For these reasons, there are no large icebergs in the north Pacific, and sailors do not have to be on the look out for them.

Julia. Even though icebergs are so much feared by the sailors, the people along the shores of the north country are never sorry to see them come down, as they are very important to the people who live along these places. Oné reason is, that when the people from Labrador and Greenland see that the icebergs are coming down, they know that there will be plenty of fish. Some kinds of fish prefer very cold water, and as the icebergs chill the water for miles around them, these fish like to swim near the bergs. Then the people get into their little boats, go out as near to the icebergs as they can and get the fish. Another use of the iceberg is that it serves as a means of supplying fresh water. If an iceberg is passing and the sun has melted it, the water collects in little hollows and the fishermen can drink it. If there is no water on the iceberg, they can break off the ice and melt it. Icebergs have sometimes served as means of transportation for animals. During the long northern winter, Labrador and Greenland are so covered with snow and ice that the animals have a hard time finding food. They sometimes venture out on the ice as far as they can go in search of food or fish. Sometimes they swim so far that they find the passage back too great, and they climb up on icebergs to regain their strength. Sometimes polar bears have been carried long distances by floating masses of ice. Although they are not native to Iceland, many people have seen polar bears there, and it is believed they were carried to that region by means of ice.

V. *Modern Ships.*—How is a Vessel Propelled by Steam?

The children bring their toy steam-engines and operate them before the class. Diagrams and models of reciprocating-engines are used and explained as far as possible by the pupils.

In order that the pupils may realize the significance of the invention of the steam-engine and the effects of its use on the structure and carrying power of ships, it is well to study the evolution of the boat from primitive types propelled by hand power to modern steam-driven craft. In our school this study is made in the woodshop as part of the manual-training course.

STUDY OF THE STEAMBOAT

In connection with the work in Geography and History for the year the handwork of the boys centered about the making of various models of historical importance in the evolution of the steamboat. These models furnished considerable material for discussion in science, principally physics of an elementary nature.

Two years previously this same grade had been interested in the making of boats and had become familiar with the law of buoyancy, which they had proved by means of simple apparatus and tests which they themselves had made. A review of this work was therefore introduced at the beginning of the year's work.

MODEL-MAKING IN THE SHOP

Why does an object float? This was the question with which the discussion opened. This seemingly simple question was quickly disposed of by the equally simple answer, "because it is lighter than water." However, objection was quickly made to this answer by one of the boys, who cited the case of steel ships, "and steel is heavier than water." The majority of the class seemed to be satisfied with the answer that it was the air inside which held the boat up. Illustrations were given of tin cans and basins floating in water until tipped in such a manner that the water entered and displaced the air. To some of the class this did not seem to be the true answer and various cases were introduced which seemed to disprove this point. Shape had something to do with it, according to some of the boys. To develop the law of buoyancy the following apparatus was devised and tests were made:

1. Two blocks of wood were made of exactly the same size, one of them being of Washington red cedar, which is very light in weight, and the other of Georgia pine, which is very heavy and full of pitch. These blocks were then gaged with lines ⅛ inch apart and then paraffined to make them waterproof.

2. A cardboard box was made by one of the boys, the inside dimensions being the same as the outside dimensions of the blocks. This was then marked with lines ⅛ inch apart and paraffined.

3. A pan of water big enough to float the blocks of wood was produced.

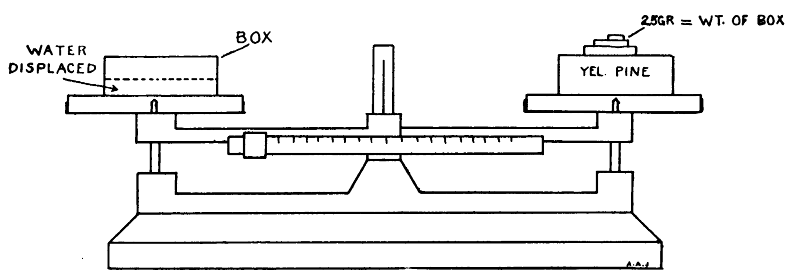
4. A pair of scales with gram weights was brought from the science laboratory.

The two blocks of wood were floated in the water and the distance to which each sank was easily noted by means of the marks gaged on the sides. The fact that one block sank deeper in the water and took up more room than the other was noted, and led to the term "displacement." The question of accurately measuring the amount displaced by each block was settled by first noting the depth to which each block sank and then pouring enough water into the cardboard box to reach a similar depth by means of the lines marked on the inside which corresponded to the lines marked on the outside of the blocks.

Now, by weighing the box with the water and deducting the weight of the empty box, the weight of the water which was displaced by the block was easily determined. Then the block was weighed and the results compared. Considering that the apparatus was made by the pupils themselves and the actual weighing and measuring was done by them, the results as set forth in the following table were quite accurate enough to prove that the amount of water displaced by the floating block of wood equaled the weight of the block itself.

TEST OF WOODEN BLOCKS

Red cedar sinks to mark	5
Yellow pine sinks to mark	9½
Weight of cardboard box and water displaced by red cedar block	193 gr.
Weight of cardboard box	25 gr.
Weight of water displaced	168 gr.
Actual weight of red cedar block	169 gr.
Difference	1 gr.
Weight of box and water displaced by yellow pine block	358 gr.
Weight of box	25 gr.
Weight of water displaced	333 gr.
Actual weight of yellow pine block	331 gr.
Difference	2 gr.



A trip to the Field Museum was made for the purpose of studying primitive types of boats, the Pacific Island out-rigger and the Eskimo kayak. Similarity in constructive principles between the kayak and the modern boat was noted and the shape as a factor in speed and seaworthiness was discussed. The copying of nature forms, such as the duck and the fish, was very evident, and some discussion was had regarding the effect which is produced when a boat is propelled through the water and the factors which must be considered, such as displacement, friction, cleavage of the water (at the bow) and the swirl or suction and eddying effect at the stern.

The next step was to classify boats as to manner of propulsion through the water. The following outline was worked out. Considerable discussion was held as to the exact chronological order of development: Rowboats (man power); sailboats (wind power); steamboats (steam power); electric boats (electric power); gasoline boats (gas power).

The length of time which the sailing-vessel had held the center of the stage compared to the other types of boats was noted and led to a discussion of the various types of sailing-vessels classified according to their rigging. Pictures were brought in by the boys to show the various types, and dictionaries, encyclopedias and books of history were ransacked to furnish their quotas for this list.

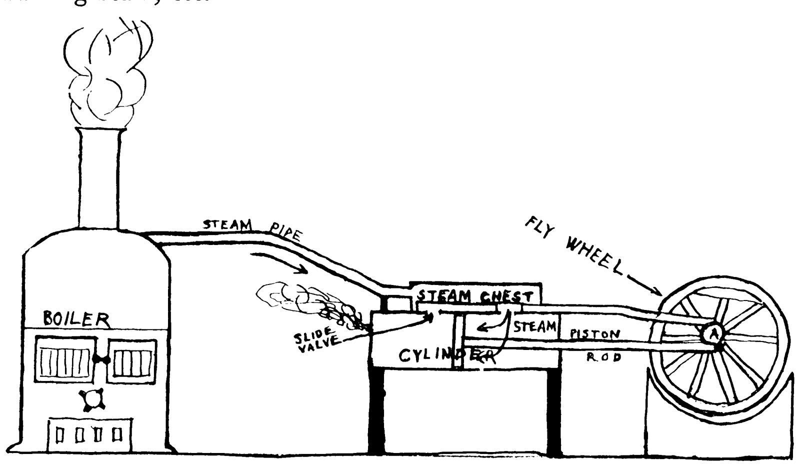
TYPES OF "WIND POWER" OR SAILING VESSELS

Canoe with outriggers	Corvette	Lugger
Canoe with lee-boards	Xebec	Felucca
Catboat	Galleon	Frigate
Schooner	Junk	Cutter
Caravel	Yawl	Ketch
Brig	Tartan	Sharpie
Barque	Barkentine	Dhow

This era in navigation could not be touched upon without reference to the various nations famed in history for their discoveries at a time when the art of ship-building was not as highly developed as at present. The following list of nations famed for seamanship was developed through discussion: Norse, Portuguese, Dutch, Greeks, Venetians, Genoese, English and New England Colonies. The importance of ships in supplying food to the Allies and starving Belgium, as well as for supplying our own troops, naturally led to a discussion of the great part that the steamship must play in the termination of the war.

The development of the steam-engine by James Watt, and the attempt to use the steam-engine for most of the necessary work of the world, naturally led the more adventurous inventors to attempt to propel boats by means of this new toy developed by the inventive genius of man. A study of the early attempts led to some interesting discoveries. While Robert Fulton's name was familiar to most of the boys as the inventor of the steamship, a closer study revealed the fact that there were others who had struggled with the idea and though reaching partial success, had failed to arrive at a practical solution. Among these were John Fitch and John Stevens and even our own Franklin. Thus Fitch and Stevens attempted to make the steam-engine copy the exact motions of the hand-propelled oar, which meant the developing of a reciprocating motion in the piston-rod of the engine, which was transferred to a circular motion in the main shaft and fly-wheel, and then again changed back to a reciprocating motion on the oars. Fulton arranged the paddles or oars from the center of the shaft, and the paddle-wheel was developed which was much more efficient.

During the time devoted to this subject several of the boys brought small steam-engines from home, and the whole class was able to study at close range the action of the steam-engine and to become familiar with the names of the essential parts. Diagrams were made and terms learned, such as reciprocating, piston, slide-valve, cylinder, walking-beam, etc.



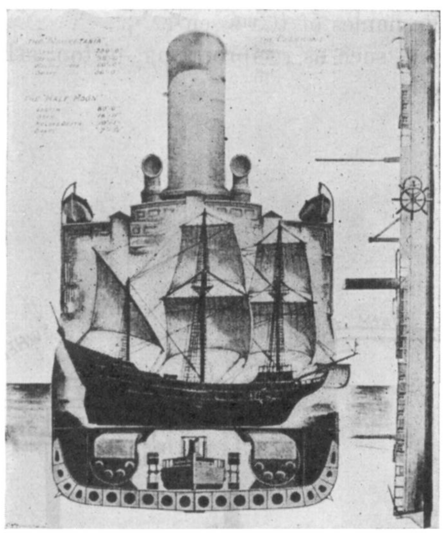
PUPILS DIAGRAM OF STEAM ENGINE

The turbine-engine as the later and more efficient development of the steam-engine was studied from pictures and descriptions in books.

In the shop work the attempt was made to construct some of the types of boats studied. Fulton's *Clermont* was one which was selected. Fitch's two types, the stern-wheel and a boat propelled by horse-power using a treadmill, were fairly successful. The size of the class (19) was somewhat of a drawback to the successful completion of many models requiring individual attention.

The benefit obtained from this study, however, was well worth the effort spent on it, even though the results on the handwork side were crude and incomplete. The admiration for the persistence with which such a man as John Fitch clung to an idea and sacrificed money and friends in his effort to reach success, was an important benefit derived from the study.

The daring displayed by the early explorers was also marveled at when it was realized that these explorers sailed uncharted seas, with crude instruments, in vessels so tiny that exact reproductions have been picked up with block and tackle and hoisted aboard our modern liners and transported across the Atlantic as a bit of baggage. These are lessons quite as important to the growing boy in dealing with the industries and work of the world as is a technique gained in the use of certain tools.



THE HALF MOON ON BOARD THE MAURETANIA
(Courtesy of the Scientific American)

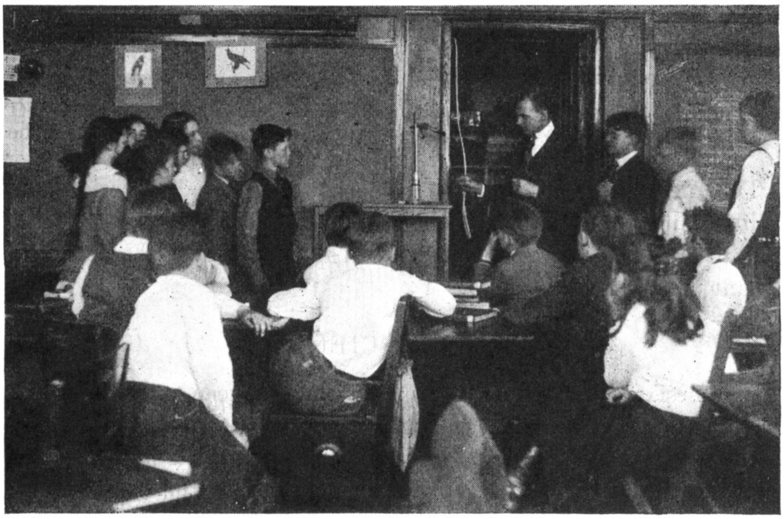
VI. *Ship-building.*—What raw materials are needed to build ships? Coal for heating and reducing iron ore; iron ore as a source of iron and steel; limestone as a fluxing material; clay for fire-brick; wood for finishing parts of vessel. The class work centers about the study of coal and the steel and iron industry.

COAL

(a) ORIGIN.—What is coal? Does vegetable matter contain carbon? What does an examination of coal tell us about the origin? What do coal-beds reveal about the earth's history?

(*b*) STRUCTURE OF COAL-BEDS.—How were folds made in the coal-beds? Earth shrinkage as a possible cause of earth folding.

Experiment.—Pour a little melted paraffin on a small rubber balloon. Allow to harden and then let some of the gas escape.



A DEMONSTRATION EXPERIMENT

(*c*) MINING COAL.—The long wall and room and pillar methods of mining coal are explained and compared.

(*d*) THE BURNING OF COAL.—What does burning mean?

Experiments.—Make oxygen from potassium chlorate. Burn carbon, sulphur, magnesium, and iron wool in oxygen. Explain the test for carbon dioxide with lime water. Burn a piece of coal in a bottle of oxygen and test the gas remaining for carbon dioxide.

IRON

(*a*) IRON DEPOSITS.—Where do we get our iron? Can it be mined like gold or silver? Where is iron found? Where are the principal iron-ore deposits of the United States?

(*b*) EXTRACTION.—How is iron obtained from hematite? In answer to this question, the steel industry is carefully studied as it is carried on at the Illinois Steel Plant at South Chicago. A flow sheet is made of the entire process of steel-making, showing the purpose of each operation. Emphasis is laid upon the following points:

1. Carbon in the form of coke steals away the oxygen from the ircn ore so as to free the iron.

2. Limestone combines with the impurities to form slag, which is afterwards used to make cement. In this connection the origin of limestone is discussed, and artificial limestone is made by cementing broken shells together with lime. The product is compared with limestone specimens in the

laboratory. The spring field-trip to Starved Rock affords excellent opportunity to study the limestone beds as they are eroded in Deer Park.

3. The Bessemer converter first purifies the iron by burning out the impurities. The iron is then converted into steel by the addition of a specific amount of carbon.

An excursion to the steel-mills is made and a morning exercise is usually given.

(c) LOCATION OF STEEL-MILLS.—Why is the iron ore brought from the Lake Superior region to Chicago? To Cleveland? To Pittsburg? To Buffalo? To Detroit? Why is not the coal shipped to Lake Superior and the entire industry located there?

The increased use of oil as a substitute for coal, especially on war-ships, and as the source of the gasoline needed by all gas-engines has led to a study of the oil industry, with an excursion to the Standard Oil plant at Whiting, Indiana.

DOMESTIC SCIENCE

In the sixth grade the children all show a keen interest in the problems related to the home. This interest, while equally strong in both boys and girls, is centered on quite different problems. For this reason the work is divided during the year, that of the boys coming in the fall and that of the girls in the winter and spring.

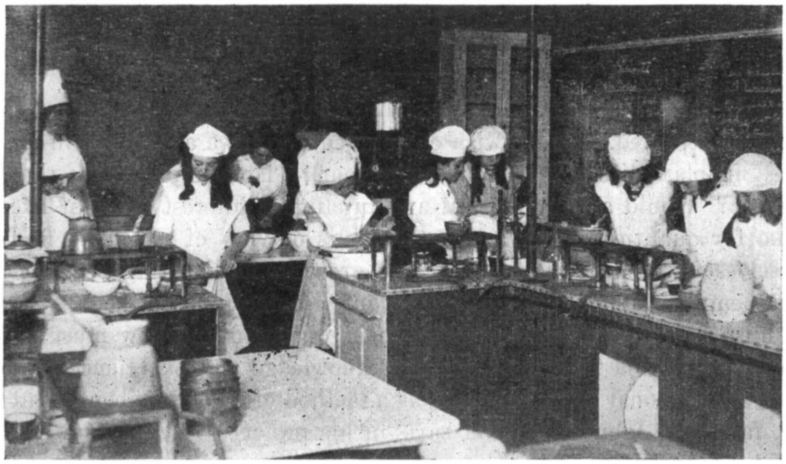
The influence of the Boy Scout movement is strong at this age as well as the natural desire to learn how to cook in camp. The work of the boys is based entirely on these interests, and each year an excursion is planned where a lunch can be cooked out of doors under true camping conditions.

The work of the girls bears directly on the home and takes up, in as broad a sense as possible, the ideals of home-making. Although based on different interests, the questions asked by both boys and girls involve the same fundamental ideas of economy, sanitation, health, and food preparation.

The need of economy and co-operation on the part of the children has been emphasized by the necessities which have come about through the war. The problems studied by the boys are as follows:

I. *Economy.*—What foods can best be cooked in camp? With regard to bulk and weight; with regard to cost? How can waste be prevented in the camp or in the home?

II. *Sanitation and Health.*—What conditions must exist if we wish to keep well? Need for cleanliness and order; proper care of food and supplies. What food materials are needed for strength and



A LESSON IN DOMESTIC SCIENCE

growth? We are asked to save necessities and to use substitutes during the war. What are the necessities? What are their substitutes?

III. *Food Preparation.*—What foods should a camper know how to cook?

OUTLINE OF LESSONS

(a) VEGETABLES.—Boiled and mashed potatoes.
(b) BEVERAGES.—Cocoa.
(c) CEREALS.—Boiled rice.
(d) MEAT SUBSTITUTE.—Macaroni and cheese.
(e) MEAT AND EGG COOKERY.—Bacon and eggs.
(f) FISH COOKERY.—Fried fish.
(g) FLOUR MIXTURES.—Pancakes, corn muffins, baking powder biscuit, ginger bread, plain cake.
(h.) MEAL COOKERY.—Lunch cooked out of doors.

The work of the girls concerns the same general topics.

I. *Economy.*—What foods are the cheapest to buy in order to get the nourishment we need? How does the cost of home-made dishes compare with those bought at the store? How can we best aid the country in its campaign to prevent waste?

II. *Sanitation.*—What conditions of cleanliness must exist if our homes are to be pleasant and healthful?

III. *Food Preparation and Service.*—What are the foods that a girl ought to be able to prepare? How can these foods be served so as to be attractive and palatable? How can variety be secured?

The ideals and care of the home, personal hygiene and all the broader aspects of home-making are introduced whenever possible